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A REDESCRIPTION OF THE AUSTRALIAN EOCENE FOSSIL MONOCOTYLEDON *PETERMANNIOPSIS* (LILIANAE: *AFF.* PETERMANNIACEAE)

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Summary

CONRAN, J. G. & CHRISTOPHEL, D. C. (1999) A redescription of the Australian Eocene fossil monocotyledon *Petermanniopsis* (Lilianae: *aff.* Petermanniaceae). *Trans. R. Soc. S. Aust.* **123**(2), 61-67, 31 May, 1999.

The fossil monocotyledon *Petermanniopsis angleseaënsis* Conran *et al.* was known previously only from a single incomplete mummified leaf from the Site II Lens B of the Anglesea Coal Mine fossil deposit, Victoria. The recognition of three additional leaf impressions with cuticles from the Site I Mesophyll and Site II Lens B lenses at Anglesea allows for the amendment of the original description to include the leaf apex and estimates of size and cuticular variability. The leaves are confirmed as acrodromous, with acuminate apices and a short drip tip. The usefulness of the unusual marginal venation in *Petermanniopsis* as an identifying feature is also discussed. In addition, the stomata are brachyparacytic and amphibrachyparacytic, rather than anomocytic, as reported previously.

KEY WORDS: *Petermanniopsis angleseaënsis*, monocotyledon, macrofossil, Eocene, Anglesea, Victoria, Australia.

Introduction

The fossil net-veined monocotyledon *Petermanniopsis angleseaënsis* Conran *et al.* is known from a partial mummified leaf recovered from Site II Lens B at the Alcoa Anglesea locality in Victoria (38° 25' S, 138° 28' E; Fig. 1) in a Late Middle Eocene fossiliferous clay lens (Conran *et al.* 1994). The geology of this deposit has been described by Christophel *et al.* (1987). Subsequent examination of the collections of fossilised leaf compressions held at the University of Adelaide Botany Department palaeobotany collection (ADU) revealed the presence of an additional three specimens referable to this taxon; two from the Site II Lens B and one from the Site I Mesophyll Lens. All of these specimens showed cuticular preservation, and two were more or less complete leaves. This enables the amendment of the description for *P. angleseaënsis* to include information about the leaf apex and to verify and/or expand the range of variation seen in the architectural and cuticular features used to define the taxon. As the specimens were from a number of different lenses from the original, it also allows for further comment on the nature of the communities in which *P. angleseaënsis* occurred.

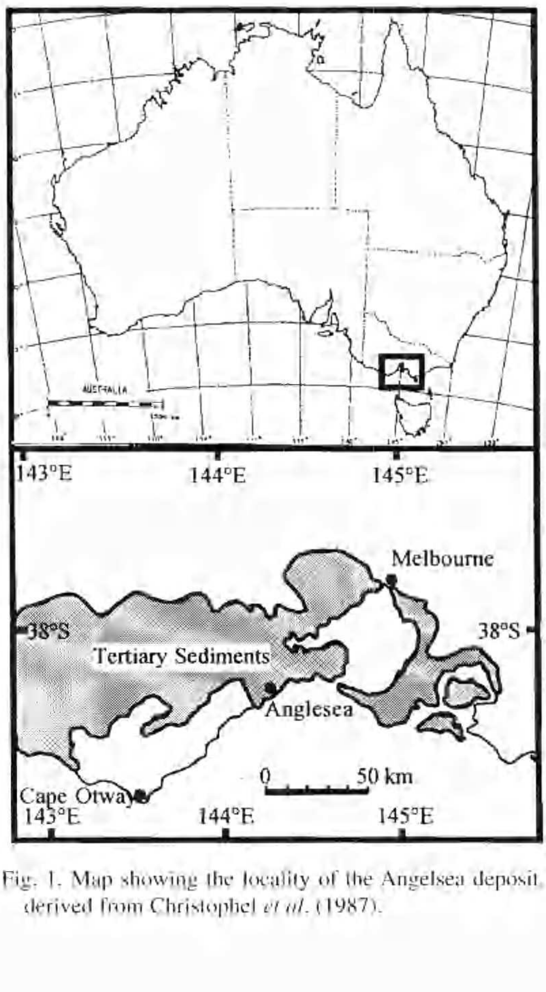

Fig. 1. Map showing the locality of the Angelsea deposit derived from Christophel *et al.* (1987).

Materials and Methods

Fossil lamina fragments were removed from the

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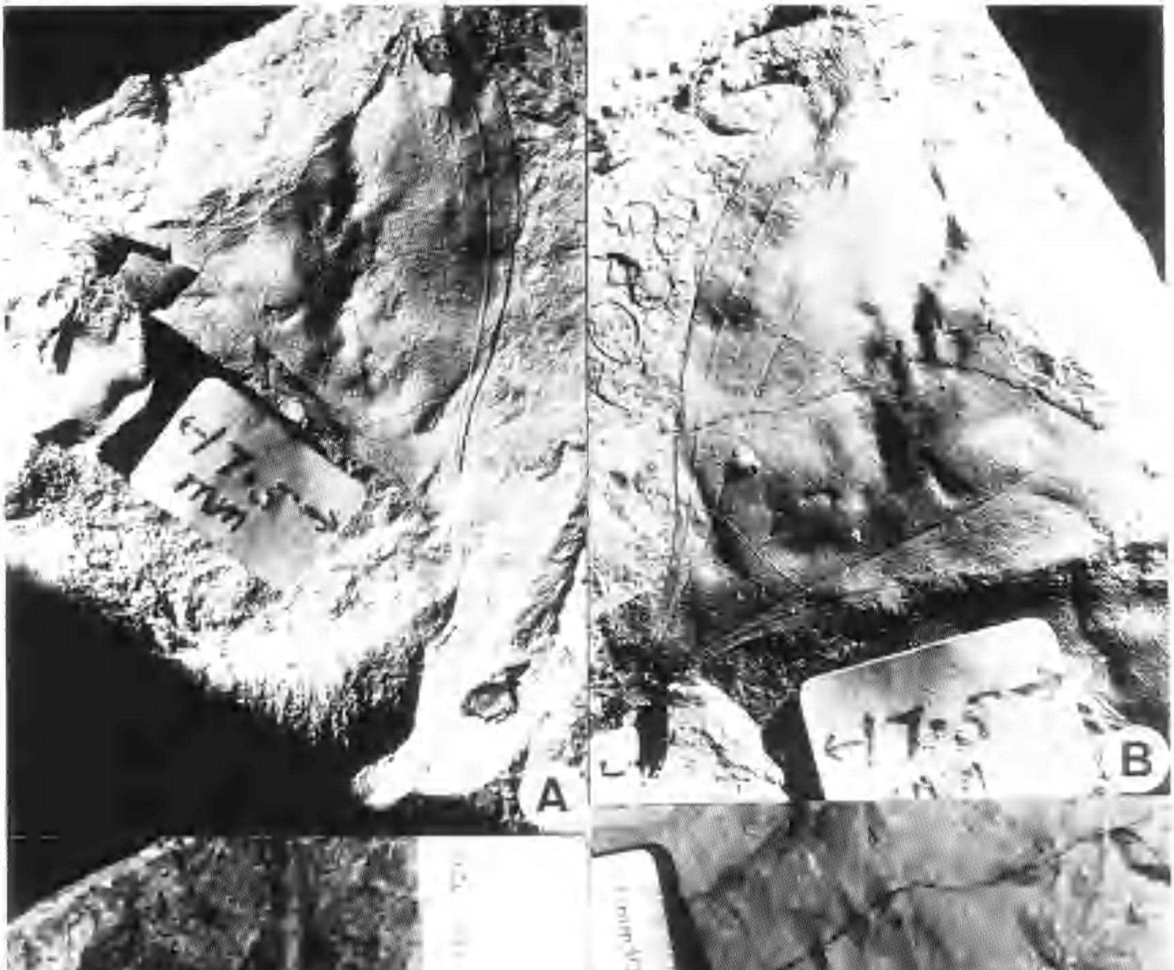

Fig. 2. *Petermanniopsis anglesaensis* specimens. A. Site II Lens B, 4087. B. Site II Lens B, 4088. C. Site I Mesophyll Lens, Mono 1. D. Ebenaceae Lens, 4122. All to indicated scales.

compressions, macerated in hot 2% w/v H_2O_2 to remove any mesophyll, and the remaining cuticular material cleaned and prepared by the methods of Christophel & Lys (1986). Leaf compression and cuticle vouchers of the taxa were deposited at ADU. Mounted cuticles were examined and photographed under Nomarski differential interference contrast optics microscopy using a Zeiss photomicroscope. Leaf morphology, venation architecture and epidermal cells and cuticles were described following the criteria outlined by Dilcher (1974), Wilkinson (1979), Conover (1983, 1991), and Baranova (1992). Leaf size class and rainforest classification follows that of Webb (1959).

Systematics

The description format follows that of Conran *et al.* (1994). Specimen numbers refer to the ADU palaeobotanical collection.

Superorder: Order Lilianae: Liliales

Family *incertae sedis aff.* Petermanniaceae Hutch. *et* Smilacaceae Vent.

Genus *Petermanniopsis* Conran *et al.*

Type species: *Petermanniopsis angleseaënsis* Conran *et al.*

Petermanniopsis Conran *et al.*

Revised description

Leaf simple, entire, symmetrical; shape ovate-elliptical; size notophyll-mesophyll; apex tapering, acuminate-attenuate with short drip-tip, base acute, tapering into a petiole. Venation acrodromous with seven primary veins (midrib plus 3 sets of paired first order laterals), the inner three noticeably stronger, all veins weakening markedly towards leaf apex. Midrib straight. Secondary veins solitary, curved, more or less regularly spaced between primaries, unbranched, emerging basally from primary veins at a low angle (15-20°) above petiole. Intersecondaries few, simple. Tertiary veins random reticulate-branched percurrent with external looping from marginal primaries and secondaries. Sub-marginal fimbrial vein present, with small dicraeoid (Y-shaped) veinlets along its length extending outwards towards margin (Fig. 3). Areoles indistinct with free-

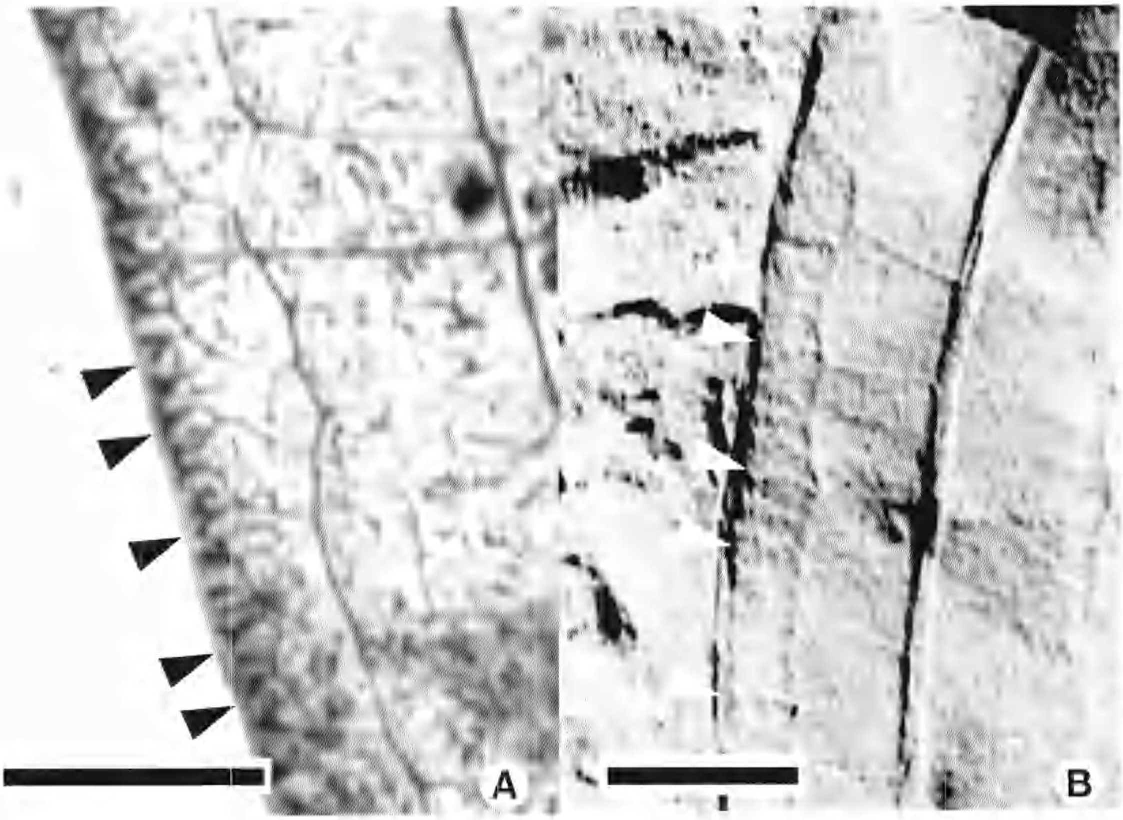

Fig. 3. Venation detail showing dicraeoid marginal branching. A. Site II Lens B 2600 (holotype). B. Site II Lens B 4087 upper. Scale bars = 2 mm.

branched vein endings. Leaves hypostomatic, stomata scattered, level with epidermis, orientation random; stomatal complex brachyparacytic, sometimes amphibrachyparacytic (e.g. Fig. 4F). Abaxial non-stomatal cells with straight to strongly curved anticlinal walls; adaxial cells slightly smaller with straight to moderately curved anticlinal walls; all non-stomatal periclinal walls without ornamentation. Trichomes, trichome bases and hydathodes absent.

Petermanniopsis angleseaënsis Conran *et al.*
(FIGS 2-4)

1994. *Petermanniopsis angleseaënsis* Conran *et al.*, *Int. J. Pl. Sci.* **155**, 816-827 (1994).

Material

Holotype: ADU 2600A (Fig. 3A). Site II Lens B, Alcoa open cut coal mine, Anglesea, Vic., *D. C. Christophel s.n.*, Nov. 1987.

Isotypes: (cuticle specimens) ADU 2600B & 2600C (Figs 4A, B), Site II Lens B, Alcoa open cut coal mine, Anglesea, Vic., *D. C. Christophel s.n.*, Nov. 1987.

Other material examined: ADU Mono 1 (Figs 2C, 4E, F). Site I Mesophyll Lens, Alcoa open cut coal mine, Anglesea, Vic., *D. C. Christophel s.n.*, Nov. 1987; ADU 4087 (Figs 2A, 3B, 4C, D), Site II Lens B, Alcoa open cut coal mine, Anglesea, Vic., *D. C. Christophel s.n.*, Nov. 1987; ADU 4088 (Fig. 2B), Site II Lens B, Alcoa open cut coal mine, Anglesea, Vic., *D. C. Christophel s.n.*, Nov. 1987; ADU 4122 (Figs 2D, 4G, H), Ebenaceae Lens, Alcoa open cut coal mine, Anglesea, Vic., *D. C. Christophel s.n.*, Nov. 1987.

Revised description

Leaf ovate-elliptic, at least 12-13.5 cm long and 3.5-5.5 cm wide. Apex acuminate-attenuate with a short drip-tip; apical angle 22-24°. Base acute, basal angle 55-70°, tapering into a petiole. Epidermal cell walls of both surfaces curved to straight, although the abaxial cells are generally larger and more strongly curved. Abaxial epidermal cells (15-40 x 13-25 μm; mean 25 x 21 μm); adaxial cells 13-25 x 13-22 μm (mean 20 x 15 μm). Guard cells 32-38 x 7-10 μm (mean 34 x 9 μm), stomatal apertures 15-18 x 7-10 μm (mean 17 x 8 μm).

Discussion

Given the present state of flux in monocotyledon classification due to realignments stemming from molecular sequencing, the placement of the Petermanniaceae and its alleged allies is questionable beyond its allocation to the Lilianae: Liliales, possibly near the Smilacaceae (Chase *et al.* 1995a,b). The new fossils both support the recognition of *P. angleseaënsis* as a taxon distinct from *Petermannia* and confirm the observation by Conran *et al.* (1994) that the leaves were probably acrodromous. The precise nature of the venation seen in these net-veined monocots is also under review, with Pole (1991, 1993) referring to the acrodromous multiple primary veins described by Conover (1983) as representing, at least in *Ripogonum scandens* J. R. & G. Forst., a true brochidodromous first order venation pattern. Nevertheless, the presence in all of the *Petermanniopsis* fossils of clear acrodromous second order venation supports the acrodromous classification of the primary venation by Conran *et al.* (1994). The marginal venation seen in the fossils is both a general feature and one apparently unique amongst the net-veined monocots. The dicracoid free veinlets extending out from the sub-marginal fimbrial vein are also not found in any other members of this group, and could be a useful character for the identification of fragmentary *Petermanniopsis* remains.

There is similar variation in the stomatal classification of these net-veined Lilianae. Although Tomlinson & Ayensu (1969), Dahlgren & Clifford (1982), Dahlgren *et al.* (1985), Conover (1991) and Conran *et al.* (1994) variously describe the cuticles of most net-veined taxa as anomocytic (including *Smilax*, *Petermannia* and *Petermanniopsis*), Gopal & Raza (1992) considered *Smilax* to be predominantly paracytic and "tricytic". Stebbins & Khush (1961) regarded the stomatal complex in the monocots to be a stable, taxonomically useful feature, although Tomlinson (1974) argued that it should only be used in conjunction with other morphological characteristics. Dilcher (1974) observed that the stomatal complex was generally unaffected by the environment, although several different types could sometimes be found on the same leaf. This condition, although rare (Baranova 1992), is known for the net-veined monocot *Dioscorea wattii* Pr. & Burk. which has paracytic, anisocytic and staurocytic stomata in addition to the more common anomocytic pattern (Upadhyay 1987). As it is not possible to study the ontogeny of the stomata in *Petermanniopsis*, cells associated with the stomatal complex can only be classified predominantly into patterns corresponding to Dilcher's (1974) brachyparacytic and amphibrachyparacytic types (Fig. 4F). This is a correction to the previous report by Conran *et al.* (1994) that the stomata were anomocytic. Unfortunately, these features do not in themselves help to relate *Petermanniopsis* more

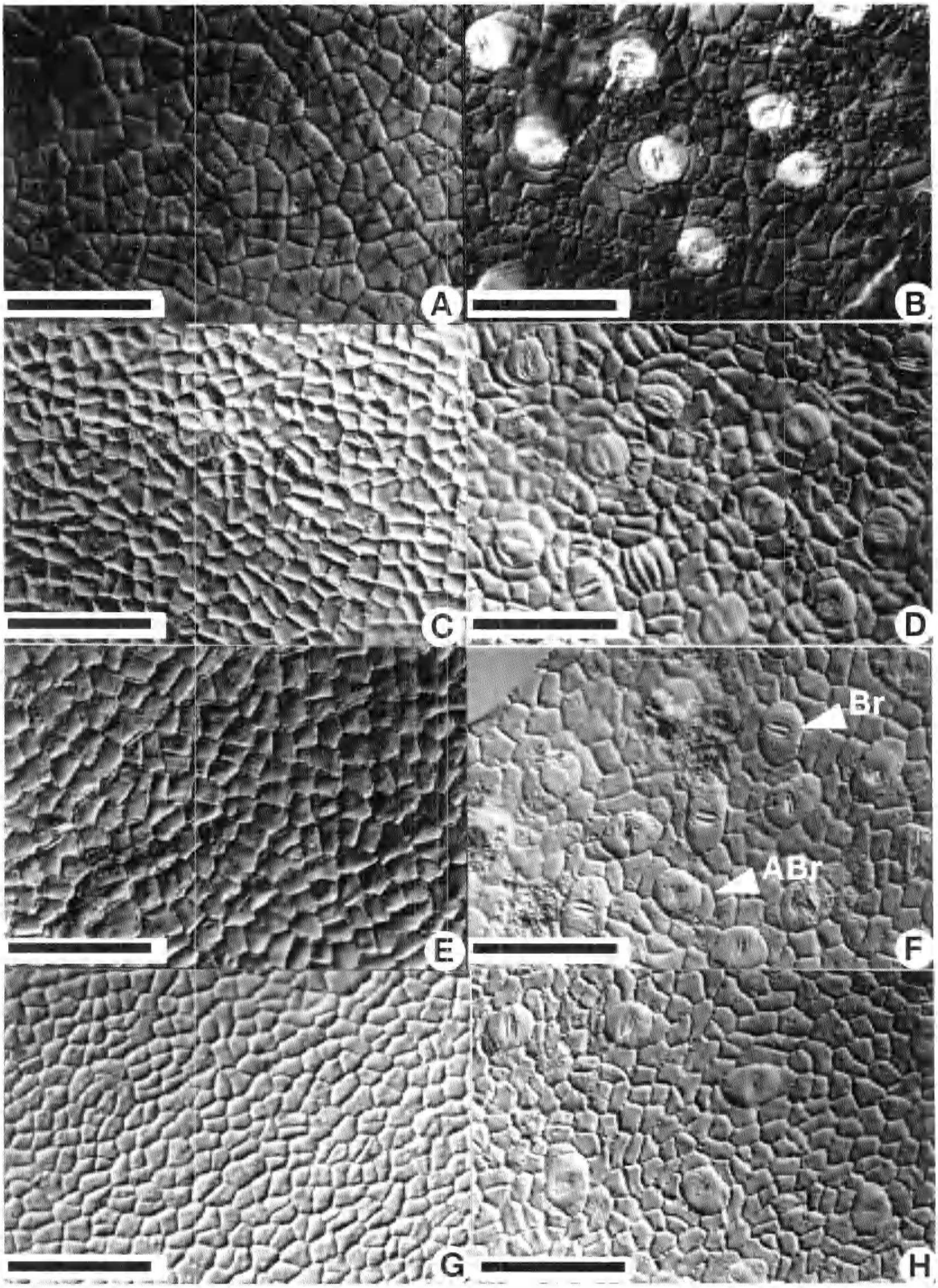

Fig. 4. *Petermanniopsis anglesea͏̈ensis* cuticles showing brachyparacytic (Br) and amphibrachyparacytic (ABr) stomata. A, Site II Lens B 2600b (isotype) upper. B, lower. C, Site II Lens B, 4087 upper. D, lower. E, Site I Mesophyll Lens, Mono 1 upper. F, lower. G, Ebenaceae Lens, 4122 upper. H, lower. Scale bars = 40 μm.

closely to other members of the net-veined Lilianae, as no other taxa have been recorded with these stomatal types.

The additional specimens from the Ebenaceae and Mesophyll lens *sensu* Christophel *et al.* (1987) are important, as their presence implies a wider habitat range for *Petermanniopsis*. This is based on the low parataxon overlap between the Site I and Site II lenses; the Mesophyll Lens dominated by mesophyll leaf parataxa (as its name suggests); the Ebenaceae Lens by entire-leaved notophyll leaf parataxa (*sensu* Christophel *et al.* 1987). In contrast, the Site II lenses contain abundant Myrtaceae and various other undescribed taxa which were either very rare or absent from the Site I lenses. The differences between the lenses were discussed by Christophel *et al.* (1987) by way of comparison with the extant rainforest community at Noah Creek in far north Queensland (16° 07' S, 145° 26' E), where the patchiness of the forest was reflected in the localised bias of the litter samples. If the habitat preferences for *Petermannia cirrosa* F. Muell. at Warrie National Park, Springbrook Plateau in southeast Queensland (26° 14' S, 153° 17' E) are examined, not only is the vegetation similarly patchy, with *Nothofagus* Microphyll Mossy Forest, Notophyll Vine Forest (NVF) and *Eucalyptus acmenoides* Schau. forest with or without NVF understorey, all within a 1 km radius of each other, but *Petermannia* is a relatively common understorey component in all of these environments (Conran 1988, 1991).

The presence of *Petermanniopsis* in several lenses suggests that it was similarly a relatively common understorey plant in the Anglesea rainforests, and one with a fair tolerance of variation in local conditions. Other present day common understorey net-veined Australian rainforest monocots such as *Smilax*, *Ripogonum* and *Dioscorea* (all of which co-occur with *Petermannia*), have not been recorded amongst the Anglesea megafossil taxa, but, given that *Smilax australis* R. Br., for example, can occur everywhere from dense rainforest to dry open eucalypt forest, the absence of these other net-veined monocots from the Anglesea fossil deposit may reflect taphonomic and preservational biases and cannot be taken as proof that they were absent from the original forests.

Now that several specimens of *P. angleseaënsis* Conran *et al.* are at hand, it may be concluded that the general leaf morphology suggested in the original description was correct and that the stomatal patterns exhibited by the taxon are variable, which is consistent with other net-veined monocot taxa. The presence of this taxon in several discrete clay lenses at the Anglesea locality, whose floristic signatures suggest a mosaic patterned rainforest structure (Christophel *et al.* 1987), also allows us to conclude that the environmental tolerances of the fossil plant were equally broad as *Petermannia* - its nearest surviving relative.

Acknowledgments

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